Tracking No	Time	Classification	Documentation		Subsystem
MER - 0	**MET:**	Problem	**FIAR**	**IFA** STS-59-V-01	MECH
MMACS-02	**GMT:**		**SPR** 59RF03	**UA**	**Manager:**
			IPR 68V-0004	**PR** MEQ-5-7-0286	x38948
					Engineer:

Title: LMG Door Uplock Indication Temporarily Lost (ORB)

Summary: DISCUSSION: At 099:11:06:01 G.m.t., 61seconds after liftoff, the left main gear (LMG) door-uplock indication (V51X0116X) transferred from 0 to 1 indicating that the LMG door was not uplocked. Ten seconds later, the indication transferred back to 1, indicating that the LMG door was uplocked. During this same time period, the LMG-uplock indication (V51X0100X) continued to indicate that the LMG was uplocked. Both of these indications provide signals to drive the LMG/door uplock discrete (V51X0115E) and the onboard landing gear talkback. Therefore, the LMG/door uplock discrete also indicated a not-uplocked condition during the 10-second time period. All LMG/door uplock indications were nominal for the remainder of the mission.

A nearly identical event occurred on STS-9 when the LMG door-uplock indication showed a not-uplocked condition for 12 seconds beginning 60 seconds after liftoff. Following this event, the indications were nominal for the remainder of the mission, and the anomaly was attributed to an improperly rigged proximity sensor as well as nominal vehicle deflections during the period of maximum aerodynamic pressure (max q). The anomaly has not recurred on OV-102. Troubleshooting performed on OV-105 showed that the LMG door-uplock proximity sensor rigging was out-of-tolerance. The proximity sensor is a two-piece variable reluctance bridge system that uses an electronic sensor and a metal target. The LMG door-uplock sensor is located on the forward wall of the LMG compartment and the target is located on the LMG uplock hook mechanism at that location. The rigging specification for a main gear door-uplock proximity sensor specifies a sensor-to-target air gap (face-to-face distance) of 0.115 to 0.155 inch and sensor-to-target alignment of 0.055 to 0.145 inch. The postflight-measured sensor-to-target air gap and alignment for the LMG door- uplock proximity sensor were 0.140 and 0.0 inch, respectively. The LMG door- uplock proximity sensor has been re-rigged. As a result of this anomaly, KSC inspected the RMG door-uplock proximity sensor and found that it too required re-rigging. The RMG door-uplock proximity sensor air gap and alignment were 0.170 and 0.042 inch, respectively. Both the left and right main gear-uplock proximity sensors as well as the nose landing gear door- and gear-uplock proximity sensors will be inspected. The rigging of the proximity sensors is not inspected during turnaroud processing, and no record exists of work being done on these sensors since OV-105 was delivered to KSC. The cause of the proximity sensors being out-of-rig is unknown at this time. The most probable cause of the anomaly is believed to be the improper rigging of the proximity sensor coupled with nominal deflections of the vehicle during the period of max q, which occurred 52 seconds after liftoff. The deflection caused the target of

the proximity sensor to move out-of-range for a brief period of time. A review of flight data indicates that the loads on the vehicle were as expected and within limits throughout ascent. The primary means of main landing gear deployment is releasing the uplock actuator using hydraulic system 1. However, the uplock actuator can also be released pyrotechnically, and 1of 2 pyrotechnic initiators is required for this backup method of deployment. The signals from the main landing gear (MLG) door- and gear-uplock proximity sensors are used in the pyrotechnic deployment logic, and therefore the signals must be correct for proper operation of the system. If a MLG door- or gear-uplock indication fails and indicates that the door or gear is not-uplocked (i.e., the door is open and the gear is deployed), the initiator utilizing an input from the failed proximity sensor would be inhibited. Therefore, the worst-case effect of a failure of an uplock proximity sensor would be loss of redundancy in deploying the main landing gear of the affected system. A complete failure of an uplock indication has never occurred during flight. CONCLUSION: The transient

Tracking No	Time	Classification	Documentation		Subsystem
MER - 0	**MET:**	Problem	**FIAR**	**IFA** STS-59-V-02	OI - Recorders
INCO-01	**GMT:**		**SPR** 59RF04	**UA**	**Manager:**
			IPR 68V-0006	**PR** INS-0171	x30663
					Engineer:

Title: No Tape Motion on MADS Recorder (ORB)

Summary: DISCUSSION: During STS-59 on-orbit operations at 101:23:15 G.m.t. (02:12:10 MET), the modular auxiliary data system (MADS) recorder (serial number (s/n) 1001) was powered up in preparation for the Global Positioning System (GPS) troubleshooting data-take. The recorder was operating on pass 1 and going in the forward direction at 15 inches per second (IPS) when activated. All initial indications were as expected. After approximately one minute of recording, the tape position reached 99.8 percent and the tape motion stopped. The track sequence status built-in test equipment (BITE) transitioned to a low state, indicating that the MADS control module (MCM) switched the recorder to pass 2 in preparation for recording in the reverse direction, as expected. Recording should have resumed in the reverse direction; however, no tape motion occurred. A series of commands was uplinked, but the commands were unsuccessful in regaining tape motion, as were a subsequent IFM and further uplink commands. The recorder was unusable for the remainder of the mission.

During postlanding troubleshooting at KSC, no anomaly was found in the MCM, and tape motion could not be restored. The MADS recorder was opened for visual inspection and was found to be parked at the first identification window, which is beyond where the recorder should reverse direction. A smoky odor was present that may be indicative of a hardware over-temperature condition. The recorder was sent to the vendor for retrieval of the ascent data from the tape and for troubleshooting. The tape has a clear window near each end through which light passes. The near end-of-tape (NEOT) sensor emits light, which is reflected off a reflective surface behind the tape when this clear window is in front of the sensor. When the NEOT receiver detects light being reflected, it generates a voltage proportional to the amount of light sensed. When this voltage exceeds a preset threshhold level, reversal of recording direction is initiated. The vendor found that the EOT circuit voltage being generated was below this threshhold. The vendor removed and replaced the NEOT sensor, the near beginning-of-tape (NBOT) sensor, and the tape. The recorder was checked out with the new sensors and tape installed and proper operation was observed. The recorder passed acceptance test procedures (ATP) and has been returned to flight spares.

The smoky odor noted previously when the cover was opened was again noted after operation of the recorder at the vendor. Since ATP uncovered no anomalous operation, this was deemed an acceptable condition and there will be no further investigation. The sensor which failed has been in this recorder since 1976. It is possible that its light generator was dirty, and this resulted in insufficient light output. No method currently exists to clean the light generator. Degradation of the light source due to component age is a possible condition. Therefore, no failure analysis was performed on the removed sensor. Although the possibility exists that the failure was due to damage to the clear window of the tape or the reflective surface behind the tape, no defects were identified in analysis. This particular sensor has never failed previous to this in-flight failure. However, two other failures similar to this failure have occurred in the history of the program. The first, in 1988, had a similar signature, and was attributed to either a weak light source or a degradation in the light sensing receiver of the NEOT sensor. The second failure occurred in 1989 and was attributed to a gap in the reflective material used to direct light back to the light sensor. All other recorders in the fleet have the original sensors that were installed between 1982 and 1986. These will be screened on an attrition basis as the recorders are returned to the vendor for any reason. A procedure is being generated to standardize this screening operation. CONCLUSION: The cause of the failure is a degraded NEOT sensor. CORRECTIVE_ACTION: The NEOT and NBOT sensors were removed and replaced, as was the tape. The recorder passed acceptance test procedures with the new sensors and tape installed and was shipped to KSC for inclusion as a flight spare. A screen will be implemented on an attrition basis to check the NEOT/NBOT voltages. EFFECTS_ON_SUBSEQUENT_MISSIONS: None. If the failure recurs, the MADS recorder would again be inoperable.

Tracking No	Time	Classification	Documentation		Subsystem
MER - 0	**MET:**	Problem	**FIAR**	**IFA** STS-59-V-03A	FC/PRSD
EGIL-01	**GMT:**		**SPR** 59RF05	**UA**	**Manager:**
			IPR 68V-0007	**PR**	x39034
					Engineer:

Title: H2 Tank 5 Check Valve Failed to Seat (ORB)

Summary: DISCUSSION: The power reactant storage and distribution (PRSD) subsystem hydrogen (H2) tank 5 outlet check valve did not seat properly after switching from H2 tank 5 to tank 4 at 101:23:05 G.m.t. (02:12:00 MET). Two days later, the check valve was exposed to high flow for one hour while performing fuel cell purges using H2 tank 5. The flow did not recover the check valve. At 105:03:48 G.m.t. (05:16:43 MET), rising manifold pressure caused by a heater- on cycle in H2 tanks 1 and 2 apparently caused the H2 tank 5 check valve to reseat, either by forcing it closed or causing a reverse flow which flushed transient contaminants from the seat. Nominal operation of the H2 tank 5 check valve was observed for the remainder of the mission.

Transient contamination most probably prevented proper seating of the H2 tank 5 check valve for several days. H2 tank 5 samples taken postflight were within specified limits with no moisture or frozen gases present. The H2 tank 5 check valve was removed and sent to the vendor (Aerodyne) for a failure analysis that will include a contaminant flush, functional tests in liquid nitrogen (LN2), X-ray examinations, and then valve disassembly. A spare check valve was installed and successfully retested. Final corrective action will be documented in CAR 59RF05-010. During STS-50 (OV-102 flight 12), a similar failure of the O2 tank 7 check valve to properly seat also recovered during the flight after several days. Postflight testing and failure analysis did not reproduce or isolate a cause for the STS-50 failure and the anomaly was dispositioned as unexplained with the most probable cause being transient contamination. A reactant leak from a PRSD tank with an unseated tank outlet check valve could allow depletion of reactants from other tanks connected to the same manifold section, and this would result in the loss of the associated fuel cell. If the associated manifold isolation valve also fails open, a second fuel cell would be lost. CONCLUSION: Transient contamination most probably prevented proper seating of the H2 tank 5 check valve for several days during the flight. A differential pressure in the reverse-flow direction probably flushed the contamination from the check valve allowing the check valve to seat. CORRECTIVE_ACTION: The H2 tank 5 check valve was removed and sent to the vendor (Aerodyne) for failure analysis. A spare check valve was installed and successfully retested. Final corrective action will be documented in CAR 59RF05-010. EFFECTS_ON_SUBSEQUENT_MISSIONS: None.

Tracking No	Time	Classification	Documentation		Subsystem
MER - 0	**MET:**	Problem	**FIAR**	**IFA** STS-59-V-03B	FC/PRSD
EGIL-01	**GMT:**		**SPR** 59RF09	**UA**	**Manager:**
			IPR None	**PR**	x39034
					Engineer:

Title: H2 Tank 2 Check Valve Sticky (ORB)

Summary: DISCUSSION: After several days of nominal operation, the power reactant storage and distribution (PRSD) subsystem hydrogen (H2) tank 2 outlet check valve opened when pressure in H2 tank 2 rose to 15 psid higher than the H2 manifold pressure during each of three consecutive heater-on cycles in H2 tanks 1 and 2 between 105:00:23 and 105:01:12 G.m.t. (05:13:18 and 05:14:07 MET). The check valve should normally open when tank pressure is 3-to-5 psid higher than the manifold pressure. The H2 Tank 2 check valve operated nominally for the remainder of the mission.

The most probable cause of the anomaly is transient contamination. A stuck- closed check valve on the outlet of a PRSD tank will prevent depletion of the tank and reduce the amount of cryogenic consumables available for mission use, and the slow rise in tank pressure caused by normal environmental heat leakage into the tank would ultimately result in operation of the tank relief valve. CONCLUSION: Transient contamination most probably caused the PRSD H2 tank 2 check valve to stick on several occasions requiring a higher differential pressure than normal to unseat the check valve. Nominal valve operation was restored after several cycles. CORRECTIVE_ACTION: None. The PRSD H2 tank 2 check valve will be reused as- is. The anomaly was temporary with the cracking pressure returning to the nominal 3 to 5 psid. The H2 tank 2 pressure did not exceed the normal tank pressure control range and did not impact crew safety or mission success. EFFECTS_ON_SUBSEQUENT_MISSIONS: None.

Tracking No	Time	Classification	Documentation		Subsystem
MER - 0	**MET:**	Problem	**FIAR**	**IFA** STS-59-V-03C	FC/PRSD
EGIL-01	**GMT:**		**SPR** 59RF10	**UA**	**Manager:**

		IPR	**PR** FCP-5-07-0060	x39034
				Engineer:

Title: O2 Tank 1 Check Valve Sticky (ORB)

Summary: DISCUSSION: After several days of nominal operation, the power reactant storage and distribution (PRSD) subsystem oxygen (O2) tank 1 outlet check valve did not open as expected at 106:16:20 G.m.t. (07:05:25 MET). The check valve opened at 106:20:54 G.m.t. (07:09:49 MET) after environmental heat raised the O2 tank 1 pressure approximately 20 psid higher than O2 manifold pressure while the manifold and the supplying O2 tank 3 pressures reached the low end of the control band. The check valve should normally open when tank pressure is 3 to 5 psid higher than the manifold pressure. The O2 Tank 1 check valve operated nominally for the remainder of the mission.

This check valve (serial number 61) experienced similar temporary anomalies during STS-33 and STS-41 while installed in OV-103 at the outlet of O2 tank 1. During STS-33, a large closing force (180 psid) was applied to the valve as a result of high O2 flow through the environmental control system caused by a momentary waste collection system leak. The high flow allowed cold, dense cryogenic oxygen to enter the manifold and then environmental heat leak caused rapid pressurization until the manifold relief opened. The check valve was not replaced as a result of this behavior after either flight. The O2 manifold valve panel assembly was removed from OV-103 for cryogenic screening of solenoid valves and was subsequently installed on OV-105. The O2 manifold valve panel assembly was removed and sent to the NASA Shuttle Logistics Depot (NSLD) for repair. The O2 tank 1 check valve was removed from the panel and will be sent to the vendor (Aerodyne) for failure analysis. A spare check valve was installed on the panel assembly and successfully retested. The most probable cause of the anomaly is transient contamination. A high closing force applied to the check valve during STS-33 may be a contributing factor. A stuck-closed check valve on the outlet of a PRSD tank will prevent depletion of the tank and reduce the amount of cryogenic consumables available for mission use, and the slow rise in tank pressure caused by normal environmental heat leakage into the tank would ultimately result in operation of the tank relief valve. CONCLUSION: The PRSD O2 tank 1 check valve exhibited a temporary sticking behavior that was caused by either transient contamination or high closing forces experienced during a previous mission, and a higher differential pressure than normal was required to unseat the check valve. Nominal valve operation was restored after the valve unseated. CORRECTIVE_ACTION: The PRSD O2 tank 1 check valve was removed and will be sent to the vendor (Aerodyne) for failure analysis. A spare check valve was installed in the O2 manifold valve assembly panel and retests were satisfactory. EFFECTS_ON_SUBSEQUENT_MISSIONS: None.

Tracking No	**Time**	**Classification**	**Documentation**		**Subsystem**
MER - 0	**MET:**	Problem	**FIAR**	**IFA** STS-59-V-04	Active Thermal
EECOM-03	**GMT:**		**SPR** 59RF08	**UA**	**Manager:**
			IPR 68V-0015	**PR**	
					Engineer:

Title: FES Supply A Accum/Hi-Load Line Sys 1 Htr Failed (ORB)

Summary: DISCUSSION: The flash evaporator system (FES) supply A (primary) accumulator/hi-load line system 1 heater failed off. This is a two element heater, with one element on the section of line leading to the supply A accumulator, the other on a section of line leading to the hi-load evaporator. Both heater elements are controlled by the same thermostat, which is located on the accumulator line. At approximately 103:05:20 G.m.t. (03:18:15 MET), the FES supply A accumulator feedline temperature (V63T1892A) reached 100 deg F and the accumulator/hi-load feedline system 1 heater cycled off normally as it had done throughout the flight. At approximately 103:05:40 G.m.t. (03:18:35 MET), the accumulator line temperature had decreased to 75 deg F, the temperature at which the heater had been cycling on. However, the accumulator line temperature continued to decrease. At the same time, the hi- load line temperature (V63T1895A) decreased from its normal operating range and within about 4 hours, both line temperatures had stabilized in the 60 deg F range.

The thermal environment from the attitudes and beta angles being flown throughout the majority of the STS-59 mission would have maintained the feedline temperatures in the 50 to 60 deg F range (above the 50 deg F fault detection and annunciation limit). Therefore, the flight control team did not ask the crew to switch to the system 2 heaters until the nominally planned heater reconfiguration time of 104:19:05 G.m.t. (05:08:00 MET). After switching to the system 2 heater, it performed nominally throughout the remainder of the mission. The system 2 heater was also used during ferry flight (system 1 is normally used). The heater was enabled and monitored for several hours at KSC and it performed nominally. No further troubleshooting was performed. The most probable cause of the failure is contamination in the thermostat. The thermostat uses a bimetallic disc to make and break contacts, and as a result, the continuity in the heater circuit. It is possible that contamination became lodged between the contacts and created a high resistance (or open) in the circuit. This contamination could then have become dislodged from the contacts when its bimetallic disc cycled due the operation of the system 2 heater. Another possible cause is an intermittent open in the heater circuit wiring. Since the heater is currently functioning nominally and a redundant heater is available, the decision was made to fly-as-is. If on a subsequent flight a similar failure/recovery occurs in this heater system, postflight troubleshooting will be performed and, if necessary, the thermostat will be replaced. CONCLUSION: The heater was enabled and monitored for several hours at KSC and it performed nominally. The most probable cause of the failure is contamination in the thermostat. A possible but believed to be less likely cause is a temporary open in the heater circuit wiring. Additional troubleshooting was not performed and the decision was made to fly the heater as-is. CORRECTIVE_ACTION: The FES supply A accumulator/hi-load line system 1 heater was tested at KSC and the failure could not be repeated. Additional troubleshooting was not performed and the decision was made to fly the heater system as-is. Any further developments regarding this anomaly will be documented under CAR 59RF08. EFFECTS_ON_SUBSEQUENT_MISSIONS: None. If the heater fails again, a redundant heater is available. If both heaters were to fail, the feedline temperature can be maintained with environmental heating. However, for some missions, controlling the feedline temperature with environmental heating could require modifying the attitude timeline and result in the loss of mission objectives. The next mission for OV-105 (STS-68), will have a thermal environment similar to the one experienced on STS-59, and the FES accumulator/hi-load line heater should not be required.

Tracking No	Time	Classification	Documentation		Subsystem
MER - 0	MET:	Problem	FIAR	IFA STS-59-V-05	GN&C
GNC-01	GMT:		SPR 59RF08	UA	Manager:
			IPR 68V-0003	PR	x31485
					Engineer:

Title: GPS Status Bit Not Changing State (GFE)

Summary: DISCUSSION: The Global Positioning System (GPS) status bit is the only GPS data available during the mission. The status bit indicates either a 1 or 0. When the GPS state indicates 1, the GPS receiver is tracking less than four satellites and the receiver is powered on. When the GPS state indicates 0, the GPS receiver is tracking four or more satellites or is powered off. The expected status bit state should toggle between 1 and 0 as satellites are acquired and lost. On the first launch attempt, the GPS receiver performed as expected for the first six hours of operation. Then the receiver remained in bit state 1 until the receiver was powered cycled. During the launch countdown, the GPS receiver performed as expected for the first four hours of operation. However, it then remained in bit state 1 for approximately seven hours until approximately launch plus eleven minutes. Postlaunch, the GPS receiver performed as expected for the first 23 hours of operation after launch plus eleven minutes. It remained in bit state 1 during this period. During the prelaunch period approximately ten minutes of GPS data were recorded.

In an effort to acquire the GPS receiver postlaunch, the lower preamplifier power was switched from bus main A to main C and also the receiver power was cycled. In both cases the GPS did not reacquire satellites. The failure of the GPS receiver to acquire satellites is due to large uncertainty in the receiver's knowledge of position and velocity. The uncertainties grow in proportion to the amount of time without four satellite navigation. The large uncertainties make it difficult to acquire satellites due to uncertainties in the satellite-to-Orbiter dynamics. The receiver would more than likely have recovered if aiding or initialization data were available. This problem was not experienced on STS-61. One major difference between STS-59 and STS-61 is the military's addition of anti-spoofing on the GPS satellite signals. Anti-spoofing is the encryption of the P-code into the Y-code. The GPS flight hardware is designed to use the Y-code when keyed. Since the receiver was not keyed, the Y-code was not available for it to track. Therefore, the receiver could only track C/A-code. It is believed that this was a factor in the off-nominal performance during STS-59 The hardware troubleshooting of the GPS was completed at KSC in mid-May. No hardware related problem could be identified. However, subsequent tests at Collins and Rockwell on like hardware have duplicated the problems experienced on STS-59. GPS internal software has been identified as the most likely cause. Software fixes have been developed and tested. Incorporation of the changes into the GPS flight hardware is planned prior to STS-68. Whether the new software is to be loaded on the GPS at KSC, or if the GPS is to be shipped to Downey or Collins for the software loading has not yet been determined. No hardware changes are planned. CONCLUSION: GPS internal software have been identified as the most likely cause of the flight problem. Software fixes have been developed and tested. Incorporation of the changes into the GPS flight hardware is planned prior to STS-68. CORRECTIVE_ACTION: Incorporation of the new software update into the GPS receiver flight hardware for STS-68. EFFECTS_ON_SUBSEQUENT_MISSIONS: None

Tracking No	Time	Classification	Documentation		Subsystem
MER - 0	MET:	Problem	FIAR	IFA STS-59-V-06	Hydraulics
MMACS-01	GMT:		SPR 59RF01	UA	Manager:
			IPR None	PR	x39033
					Engineer:

Title: WSB 2 Failed To Cool (ORB)

Summary: DISCUSSION: During ascent, water spray boiler (WSB) 2 (serial number 017) data did not show any indication of spraying for auxiliary power unit (APU) lube oil cooling. When the APU 2 (serial number 401) lube oil return temperature reached 305 degrees F at approximately 099:11:19 G. m. t. , WSB controller B was selected. No water spraying was seen on controller B. APU 2 was shutdown early at approximately 099:11:20 G. m. t. when the APU 2 lube oil return temperature reached 323 degrees F and the bearing temperature reached 348 degrees F. During the approximately 2 minute duration between APU 2 shutdown and WSB 2 spray logic deactivation, the data indicated no water spraying, even though the elevated temperatured of the APU 2 lube oil should still have demanded spraying. This type of hard freeze-up has been seen on one previous flight, STS-43.

An extended flight control checkout (FCS) on system 2 was performed because of the lack of spraying during ascent. WSB 2 performed nominally with spraying on both controllers. Approximately 7.5 minutes after APU 2 start on controller B , lube oil return temperatures reached 250 degreees F and spraying was immediately initiated with no evidence of over temperature or delay indicating that the ice in the boiler had sublimated following ascent. Controller A was selected 2.5 minutes later with no interruption of spraying. Approximately 30 seconds later, a minor overcool down to 244.8 degrees F was observed. The system quickly corrected itself by APU 2 shutdown 1 minute later. This small overcool is not a concern and has been seen previously on numerous flights. There is no explanation for this particular overcool although it is suspected to be related to switching control circuits during spray cooling. Water usage was approximately 1.7 pounds, which is nominal for this spray duration. APU 2 was activated first for entry at time of ignition (TIG) minus 5 minutes. WSB 2 water usage for cooling during entry was 21.0 pounds which was within specifications. Stabilization of the lube oil temperature near the boiling point of water indicated a properly functioning hydraulic spray valve, spray control sensor, and controller spray logic circuit for WSB 2. WSB 2 is suspected to have experienced a hard freeze sufficient to inhibit spraying. During the mission, due to the hard freeze signature, Rockwell- Downey performed several vacuum chamber tests to characterize the hard freeze phenomenon. Testing was conducted with 80 ml of water, core heaters on, a vacuum chamber temperatureof 55-60 degree F and a pressure of approximately 4 torr to simulate on-orbit conditions. The test results indicated that frozen spray bars would thaw out completely allowing spray initiation in approximately 3 hours. Nominal KSC checkout of the hydraulic and WSB system was performed with good results. No special testing was requested because of the good spray cooling observed during FCS checkout on both controllers. A design change to the WSB is in progress to eliminate the hard freeze phenomenon. Heaters are being designed for installation on the water feed line between the APU spray valve and the APU spray bars. The implementation of the design change will start with STS-69 on OV-105. During an abort a WSB hard freeze would force early shutdown of the APU post-MECO and delay restart until Mach 1. The Orbiter is certified for 2 of 3 hydraulic sytems for an abort /entry. To have criticality 1 situation, two WSB hard freeze ups must occur for an abort during ascent. The program has never had two simultaneous hard freeze up during any ascent. For nominal ascents, WSB freeze up is a non-critical/manageable condition. A verification of the WSB health during an extended FCS checkout will demonstrate entry viability. If the WSB failed to spray during FCS checkout, the associated APU would be started at Terminal Area Energy Management (TAEM) and shutdown after wheel stop. CONCLUSION: WSB 2 is believed to have had a hard freeze of the spray bars. The spray bars did not thaw out until after ascent which has been confirmed by test at Rockwell. The freeze-ups are known to be caused by design limitations of the WSB. CORRECTIVE_ACTION: Nominal ground turnaround testing was scheduled for the WSB 2 system because of the good spraying seen on FCS checkout and entry. The checkout is completed and the results were good. A design enhancement to the WSB system is in work to eliminate the freeze up problems. The design change is the addition of heaters near the spray bars to prevent freezing of the water. The design will be implemented by starting with STS-69 on OV105. Any additional testing or analysis for this problem will be document in CAR 59RF01- 010. EFFECTS_ON_SUBSEQUENT_MISSIONS: Two WSB hard freeze ups must occur for an abort during ascent to have a criticality 1 situation. For nominal ascents, a WSB freeze up is a non-critical/manageable condition.

Tracking No	**Time**	**Classification**	**Documentation**		**Subsystem**
MER - 0	**MET:**	Problem	**FIAR**	**IFA** STS-59-V-07	C&T - Ku-band
INCO-03	**GMT:**		**SPR** 59RF12	**UA**	**Manager:**
			IPR	**PR** COM-5-07-0083	x31719
					Engineer:

Title: Ku-band Range/Elevation Indicator Failed (ORB)

Summary: DISCUSSION: The crew reported that the units digit on the Ku-Band Range/Elevation indicator failed off and the fault light on the Range/Elevation and Range Rate/Azimuth digital display unit was illuminated at 108:13:38 G.m.t. (09:02:33 MET).

Postflight troubleshooting isolated the fault to a problem within the Range/Elevation and Range Rate/Azimuth digital display unit. The display was removed and sent to the NASA Shuttle Logistics Depot (NSLD) for test, teardown, and evaluation (TT&E). A spare display unit was installed and will be retested during the Ku-Band self-test procedure, scheduled to be performed late in the Orbiter processing flow. CONCLUSION: The problem was caused by a fault within the Range/Elevation and Range Rate/Azimuth digital display unit. CORRECTIVE_ACTION: The Range/Elevation and Range Rate/Azimuth digital display unit was removed and sent to the NSLD for TT&E. Final corrective action will be documented in CAR 59RF12-010. EFFECTS_ON_SUBSEQUENT_MISSIONS: None.

Tracking No	**Time**	**Classification**	**Documentation**		**Subsystem**
MER - 0	**MET:**	Problem	**FIAR**	**IFA** STS-59-V-08	OMS/RCS
PROP-01	**GMT:**		**SPR** 59RF14	**UA**	**Manager:**
			IPR 68V-0009	**PR** RP01-0724	

Engineer:

Title: Right RCS Fuel Manifold 4 Iso-Valve failed to indicate closed during the post-landing redundant circuit verification testing. (ORB)

Summary: DISCUSSION: During the post-landing redundant circuit verification testing (MET 11:06:13) the right RCS fuel manifold 4 isolation valve failed to indicate closed when the switch was cycled to the close position. The crew cycled the switch to open, close, back to open and then closed with the same indicated results. Manifold pressure data indicated that the valve closed each time.

The microswitch used in this OMS/RCS AC motor valves uses a 28V DC power source to generate open and closed position discretes. Similar failures have occurred in the past on AC motor valves with non- Particle Induced Noise Detection (PIND) tested switches. Loose contamination (metallic and non- metallic , ref. CAR 52RF08) internal to the limit switch can result in an electrical short or open circuit of the limit switch. PIND testing was implemented as a means for screening microswitches with loose internal contamination. Prior to implementation of PIND tested switches, failure of this nature was relatively high. However, in the past several years, failure rate has gone down dramatically primarily due to the attrition of non-PIND tested switches in the OMS/RCS system. The result of a contaminated switch can be either loss of telemetry, loss of crew talkback operations, or application of continuous power to a valve. CONCLUSION: The most probable cause of this anomaly is contamination in the actuation limit switch module. This condition has been seen in the past (IFA 52-V- 13, CAR 52F08-010). This valve is one of an older configuration actuator (-101) which contains the Non - Particle-Induced Noise Detection (PIND) tested valve position indicator switch assemblies. All new and refurbished actuators contain PIND tested switches (ref. CAR 36RF09). All CRIT 1 valves (crossfeed and tank isolation valves) in the OMS/RCS system have PIND tested switches. CORRECTIVE_ACTION: KSC troubleshooting has isolated the problem to the actuator. Previous failure history indicates a failure of the microswitch as the most probable failure mode. The actuator has been removed and replaced with a PIND tested actuator. The retest of the new actuator has been successfully completed. The actuator has been shipped to Parker Hannifin for TT&E and possible failure analysis. This activity will be tracked under CAR59RF14. Resolution: Closed to CAR59RF14 EFFECTS_ON_SUBSEQUENT_MISSIONS: None

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Tracking No	Time	Classification	Documentation		Subsystem
MER - 0	**MET:**	Problem	**FIAR**	**IFA** STS-59-V-09	APU
None	**GMT:**		**SPR** 59RF15	**UA**	**Manager:**
			IPR None	**PR**	
					Engineer:

Title: Unexplained APU 2 Gearbox GN2 Bottle Pressure Changes (ORB)

Summary: DISCUSSION: The auxiliary power unit (APU) 2 (serial number 311) gearbox GN2 bottle pressure (V46P0252A) displayed an abrupt downward pressure shift of approximately 4.4 psi over about a 10 second period during ascent, flight control system checkout, and entry runs of the APU when the bottle pressure reached about 170 psia. Note that the GN2 bottle pressure normally rises at about 2 to 4 psi/minute during APU runs due to heat transfer into the fixed volume GN2 bottle. The pressure measurement remained shifted down throughout each APU run and after APU shutdown until the GN2 bottle pressure decreased to around 170 psia during the soakback period. At this point, an approximate 4.4 psia upward shift was observed over a 2 minute period.

Review of the history of this pressure transducer showed that the downward and upward pressure shifts have been experienced on APU 311 on five previous flights on three different vehicles and in all three APU positions. APU 311 flew 3 flights as a baselined APU and 2 flights, including STS-59, as an improved APU. The APU has had a total of 17 runs during the five flights. Data have been reviewed on 15 of the 17 runs and in every case the peculiar pressure measurement shifts are similar. Detailed examination of the pressure measurement signature shows that the rate of the pressure shifts is relatively constant and is uniform and predictable for each run. It appears as if the shifts are associated with temperature changes as the APU warms up and cools down. The two runs that have not been reviewed were the confidence runs for STS-28 and STS-38, and the data are unavailable. It should be noted that when APU 311 was refurbished from a baseline APU to an improved APU, the pressure transducer and wiring harness connectors were reused. The harness itself was replaced. The function of the GN2 bottle pressure measurement is to indicate the amount of gas in the bottle and is also used to indicate when gearbox repressurizations occur. The gearbox pressure measurement (V46P0n51A; n = 1,2,3) can also be used to determine when repressurizations occur. The GN2 bottle pressure measurement function is not affected by the pressure shifts. CONCLUSION: The most likely cause of the peculiar pressure shifts is a thermomechanical change within the GN2 bottle pressure transducer which occurs at the same temperature/pressure each time the APU is run. The phenomenon apparently causes the transducer's electrical output to change resulting in about a 4.4 psi downward pressure shift when the pressure reaches > 170 psia and returns to normal when the pressure is < 170 psia. The pressure shifts are inherent to this particular transducer (since the peculiar shifts have not been observed on any othe APU) and does not affect the measurement function. However, the specific internal mechanism causing the shifts is unexplained. CORRECTIVE_ACTION: No corrective action is warranted. The pressure transducer will not be removed from the APU since the past APU run history show the pressure measurement shifts to be uniform and predictable. The peculiar pressure shifts do not affect the pressure measurement function. The measurement is a criticality 3/3 and is not a control input for any electrical circuitry. There is no safety of flight concern if the measurement is lost completely. The measurement is reviewed each flight and will be corrected if complete failure occurs. EFFECTS_ON_SUBSEQUENT_MISSIONS: None.

Tracking No	Time	Classification	Documentation		Subsystem
MER - 0	**MET:**	Problem	**FIAR**	**IFA** STS-59-V-10	MECH
None	**GMT:**		**SPR** 59RF16	**UA**	**Manager:**
			IPR 68V-0019	**PR**	x38948
					Engineer:

Title: LH and RH Inboard Tire Damage (ORB)

Summary: DISCUSSION: During post-landing inspection, the left hand inboard (LHIB) and right hand inboard(RHIB) tires were found to have excessive wear on the second rib from the strut. The tires shed approximately 15-20 percent of the second rib. The excessive wear is the worst experienced of the four Edwards Airforce Base flights since the change to the new commercial tread rubber compound tire.

The runway inspection showed unique skid marks near the vehicle stopping point. The LHIB tire left the following marks just prior to the vehicle stopping: 30 feet from stop, a 6 foot mark; 23 feet from stop, a 2 foot mark; 13 feet from stop, a 1 foot mark; and at the final stopping point of the vehicle. In addition, a piece of rubber compound was found approximately 50 feet from the vehicle stopping point. These excessive tread wear patterns are a result of the high main gear touchdown velocities, a maneuver back to centerline, and abrupt braking at 10 knots without anti-skid protection. The vehicle main gear were touched down at 228.3 knots ground speed. The target touchdown speed was 205 knots equivalent airspeed(KEAS); actual KEAS for touchdown was 215.4. Just after touchdown, the vehicle drifted approximately 32 feet left of centerline; no crosswind. At ~148 KEAS the commander began a corrective action; centerline was achieved at ~84 KEAS. Lateral velocity during the maneuver peaked at 4.32 feet per second along with an inertial side slip angle peak of -.87 degrees midway through the correction. During rollout, the brakes were utilized nominally with low brake energies. However, just before wheel stop, the brakes were released and abruptly reapplied at 10 knots. A review of historical tire wear indicates that the number 2 rib (6 ribs per tire) incurs higher levels of wear than other areas of the tire. This wear has been attributed to axle deflection which generates a higher tire loading on the number 2 rib. STS-59 tire wear was characteristic of previous flight tire wear. CONCLUSION: The tire wear experienced during STS-59 is characteristic of previous flight tire wear. The additional tire wear was due to a high main gear touchdown velocity, a corrective maneuver during rollout, and low energy braking without antiskid protection. CORRECTIVE_ACTION: Review the Flight Rules that pertain to landing site/runway selection and touchdown velocities to minimize exposure to tailwind landings that can cause excessive touchdown velocities which exceed tire/gear certification. Review pilot technique and training in an effort to minimize tire wear during rollout maneuvers. EFFECTS_ON_SUBSEQUENT_MISSIONS: STS-59 typical tire wear can be expected on future flights with high touchdown velocities.

Tracking No	**Time**	**Classification**	**Documentation**		**Subsystem**
MER - 0	**MET:**	Problem	**FIAR**	**IFA** STS-59-V-11	ECLSS
None	**GMT:**		**SPR** None	**UA**	**Manager:**
			IPR None	**PR**	x33646
					Engineer:

Title: Wet Trash (Volume F) Grommet Failure (ORB)

Summary: DISCUSSION: During on-orbit operations of STS-59, the grommet at the opening to the wet trash compartment (Volume F) came out of its retainer and was pushed into the bag. This same failure mode has occurred on several previous flights. Discussion with the STS-59 crew and other crews revealed that this happens quite frequently, and a contributing factor is inserting large items through the grommet. Inspection of the hardware revealed that no out-of- specification conditions existed in the grommet or the retainer. However, there is slight distortion evident in the older grommets.

Several fixes to the problem were considered. The one selected was to use a Neoprene adhesive in the slot to glue the grommet in place. The Technical Order (M072661604-007) was changed to reflect this new procedure, which involves applying Neoprene in the slot, inserting the grommet, and curing for 24 hours. The drawing (V604660640-005) will be updated accordingly. The adhesive will be applied and new grommets installed for all flights after STS- 65.   CONCLUSION: The grommet came out of its slot due to insufficient holding forces in the slot. Mild distortion and large trash items contributed to the grommet coming out of the slot, even though no out-of-specification conditions existed.   CORRECTIVE_ACTION: A new grommet will be glued in place for all flights after STS-65. EFFECTS_ON_SUBSEQUENT_MISSIONS: None. If the grommet comes out again, the crew can reinsert it.